
Space Weather Technical Forecast

Issued on Wednesday, 13 September 2023 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further M-flares likely (R1-R2 radio blackouts). Slight Chance of G1-G2 Minor storms throughout given likely coronal hole influence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity, with two M-class flares observed in the last 24 hours. The strongest of these was an M2.5 flare from AR3423 in the west at 12/0707 UTC. There are seven active regions visible on the disk. AR3423 remains the largest spot on the disc, but has shown little recent development and remains magnetically simple. AR3425 looks to have lost a small and weak delta spot on its trailer portion, but remains an otherwise modestly sized region comprised of a number of smaller spots. AR3429 in the eastern disk showing increased magnetic complexity but only slow growth, with the region to its southeast maintained as a NEW as yet un-numbered mature solo spot. AR3430 and AR3431 also saw some slight waxing and waning, with AR3431 maintain its more complicated north-south magnetic configuration. AR3433 (Hsx/Alpha) in the northeast was numbered, with AR3427 in the southwest fading and AR4332 rotating off the visible disk.

No Earth directed CMEs observed during the past 24hrs.

Solar Wind / Geomagnetic Activity: Solar wind was observed at L1 by ACE/DSCOVR, were slow-ambient at first around 360-380km/s, but rose sharply from approximately 12/1120 UTC to slightly elevated levels around 400-420km/s with the arrival of a CME before falling erratically back to generally slow levels from around 12/1430 UTC. The density followed a similar pattern, rising from average values to a peak of approximately 70ppcc following the arrival of the CME before erratically dropping back to average levels. The Interplanetary Magnetic Field (IMF), Bt, was weak initially, but rose sharply to moderate to strong levels with the arrival of the CME, peaking at around 20nT at approximately 12/1400UTC before slowly declining to moderate levels as Earth looks to have entered the magnetic cloud associated with the CME. The north-south component, Bz, was weakly positive initially, but became moderately negative (southward) with the arrival of the CME and strongly negative upon entering the likely magnetic cloud, seeing a peak of -19nT before slowly rising to more weakly negative levels. Phi angle was negative to start, but becoming positive following the the arrival of the CME. Geomagnetic activity was Quiet (Kp 1-2) initially, but rose to give G1 Minor Storm (Kp 5) conditions on the 12-1500UTC and 15-1800UTC intervals, and remains at unsettled to active levels (Kp 3-4).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background. GOES16 high energy (greater than 2MeV) electron flux was at background to moderate levels. The associated 24-hour fluence was well below the Active threshold, with 2.77e6 integrated pfu observed at 13/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate activity is expected to continue with further isolated M-flares likely and a slight chance of isolated X-flares.

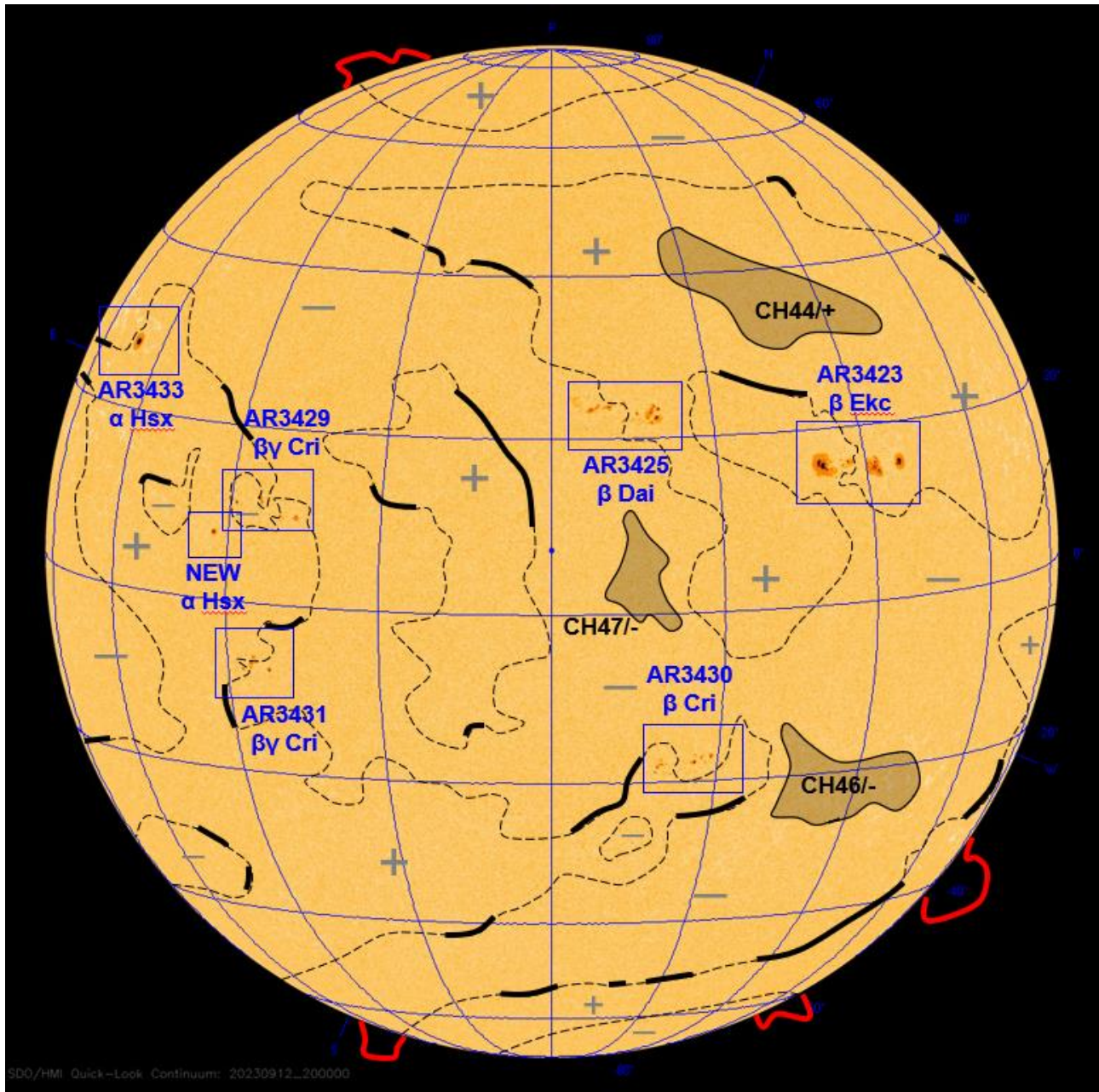
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

Solar Wind / Geomagnetic Activity: There is one Earth-directed CME in the forecast. This is from the filament eruption that occurred around 11/1400 UTC that gave a CME off towards the south. This has been analysed and may give Earth a weak glancing blow possibly later on Day 3 (15 Sep).

Recent unexpected CME influence appears to be waning with a return to a more ambient regime expected at least in the short term. Coronal hole fast wind enhancement expected into the forecast period however, firstly most likely from CH44/+ in the northwest disk, though ENLIL model output continues to signal CH46/- in the southwest as the dominate feature. Some influence from either or both these features expected through Day 1 into Day 2 (13-14 Sep) with an increase in winds to slightly elevated to elevated levels (450-550km/s) likely. Into Day 3 or more likely Day 4 (15-16 Sep) some connection to CH47/-, currently near centre disk, is likely. This features was perhaps the source of some strong solar winds (around 600km/s) on the last solar rotation, with a chance that winds may reach these levels by the end of the period. This creates a complex and low confidence forecast, with a variety of potential coronal hole interactions, and little assistance from ENLIL modelling. Overall, largely Unsettled to Active (Kp3-4) geomagnetic activity is forecast, with a continuing slight chance of G1-G2 Minor Storm intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with a very slight chance of an enhancement should any larger flares occur. High energy (greater than 2 MeV) electron flux may increase to Moderate to High levels initially, but is expected to return to background levels into the period. Overall, the 24hr fluence is expected to remain below the Active threshold, but with a slight chance of rising above early in the period.

Figure 1. Solar Analysis Valid 12/2000 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There is one Earth-directed CME in the forecast, due to a filament eruption in the south-centre disc around 11/1400 UTC. This gave a CME off the southwest disc, which appeared slow and relatively faint in imagery. Analysis has shown that this may give Earth a weak glancing blow possibly later on Day 3 (15 Sep), with little impact expected.

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Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	20	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/0002	Partial	Filament eruption	South-centre disc	450 km/s	15/0600+-09hr	Limited impact expected

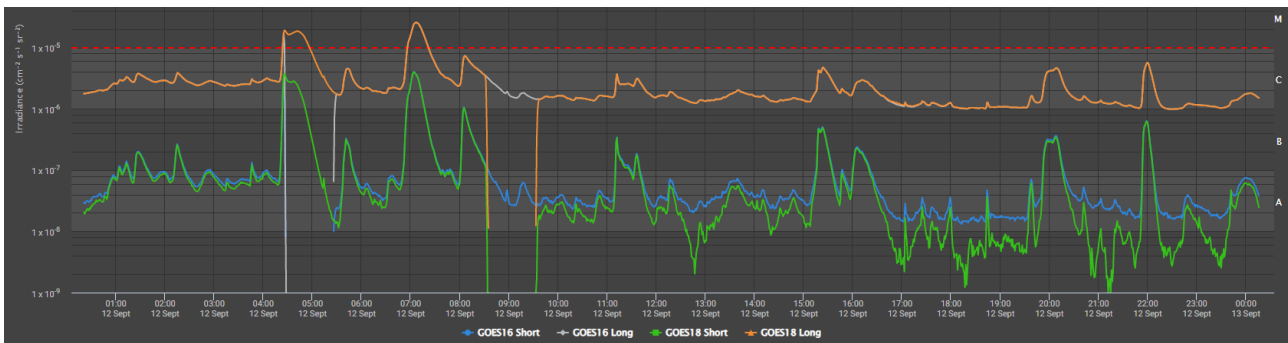
Radio Blackouts - X-Ray Flares:

Generally Moderate activity is expected to continue with further isolated M-flares likely and a slight chance of isolated X-flares.

There are currently seven active regions visible on the disk. AR3423 remains the largest sunspot region and has been responsible for the largest observed flare in the past 24 hrs. This region currently provides the bulk of the flare risk, however it has remained relatively magnetically simple. Further isolated M-flares likely remain possible as it continues to rotate west however. AR3425/29/30 and 31 are all smaller, but more or less magnetically complicated regions consisting of multiple smaller spots. All of these region producing some level of flare activity and add to what is a fairly active disk. The remaining regions on the disc are simpler and largely inactive. No significant sunspot departures expected during the period with far-side sounding data suggesting the potential for further regions to rotate on into days 3/4 (15/16 Sep) therefore current flare risk maintained throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: Latest 24hr GOES16/18 X-Ray trace



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels. There remains a very slight chance of flux levels rising in response to any significant flaring, particularly as AR3423 and AR3425 continue to move across the western hemisphere.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy (greater than 2 MeV) electron flux observed by GOES-16 may increase through Day 1 (13 Sep), rising to Moderate, perhaps High at diurnal peak, with the recent unexpected CME likely to have increased the flux through the Van Allen belts. However this rise is low confidence, with the potential for any coronal hole fast wind arrival to disrupt the belts and lead to a drop out in observed flux which may only slowly recover later in the period.

The associated 24-hour fluence will most likely remain below the Active ($1\text{e}8$ integrated pfu) threshold. Confidence for this is somewhat reduced however, with a slight chance of rising above during Day 1 (13 Sep) largely depending on the length of time until any drop out occurs from expected coronal hole high speed stream influence. MOSWOC REFM is considered to be giving generally good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	20	10	10	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output

